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STUDIES RELATED TO FLEX-WALL TEST-SECTION

Theoretical studies required to evaluate and validate the streamlined wall test section of the 0.3-m transonic Cryogenic Tunnel have been initiated. The various aspects that are being considered presently are deviations of the real wall shape from the true streamline shape, wall adjustment strategy, and the influence of the sidewall boundary-layers.

Since the top and bottom walls are supported at a finite number of jack points, the true wall shape will be different from the ideal streamline shape. This is being determined by calculating the structural shape for cases for which the exact streamline shape can be calculated. For the structural shape calculations, the MSCNASTRAN code is being used. To start with, comparisons will be made using simple singularities for model representation and also for a flat plate at angle of attack.

The accuracy to which the wall shape can be deemed to represent the true streamline shape depends on the wall adjustment strategy adopted. Presently, the method proposed to be used in the 0.3-m TCT treats the top and bottom walls separately by representing them by a finite number of vortex panels. The aerodynamic coupling between the two walls is then accounted for by an empirical factor. An alternative approach which directly accounts for the coupling of the top and bottom walls is possible by using the Cauchy's integral method. This method has been used in Reference 1

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for some limited wall streamlining studies. An evaluation of this method is planned to be made with the 0.3-m TCT data on wall shapes expected to be available in the near future.

Recently, the effect of sidewall boundary-layers in two-dimensional airfoil testing has been receiving considerable attention. While the influence can be complicated, particularly at transonic speeds, it appears now that at least some of the major effects can be explained in terms of a negative blockage effect due to thinning of the sidewall boundary-layer under the favorable pressure gradient imposed by the airfoil pressure field. In addition to the simple global corrections found to be quite effective for the airfoil data obtained in the earlier 2-D test-section of the TCT, detailed calculations of the development of the sidewall boundary-layers similar to that in Reference 2 is planned. It is speculated that such detailed calculations may be necessary for long chord airfoils intended to be used in the flex-wall test-section.

Further, it has been planned to test two different chord supercritical airfoils at a later date in the flex-wall test-section. The intent of these tests is to identify the effect of airfoil aspect ratio on the maximum lift coefficient.

ASPECT RATIO EFFECTS IN 2-D AIRFOIL TESTING

A modification to the sidewall boundary-layer correction proposed in References 3 and 4 was derived by representing the crossflow velocity variation by the flow between a wavy wall and a fixed wall. This modification accounts for the aspect ratio of the airfoil in an indirect manner and shows that the sidewall boundary-layer effects to decrease considerably with

increasing aspect ratio of the airfoil. The proposed modification involves multiplying the results of References 3 and 4 by a factor equal to k/sinh(k), where k is inversely proportional to the wave length of the wavy wall. Assuming the wave length is typically equal to the chord of the airfoil, the modification appears to give good results for the correlation of the shock positions measured on a super-critical airfoil in the ONERA tunnel. The value of k largely depends on the pressure signature of the airfoil on the sidewall, and a suitable value in terms of the chord length can be arrived at by comparing it with the experimental data. The details of the work will be documented in a separate report.

ACTIVE BOUNDARY-LAYER REMOVAL TESTS

A paper describing the details of the active sidewall boundary-removal system of the 0.3-m TCT and its performance evaluation results was prepared and presented at the 63rd meeting of the Supersonic Tunnel Assocation. Similar tests have been planned with the new flex-wall test section, and necessary test setup accessories are being fabricated separately. A copy of the paper presented at the STA meeting is enclosed (Appendix A).

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